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Spraying with tar oil-petroleum oil combination for the control of aphis and San Jose scale. Thorough spraying of limbs and twigs is necessary for aphis control. Apply tar oil sprays only when fruit trees are dormant.

Tar Oil Distillates As Dormant Spray Materials for Fruit Trees

By R. H. Hurt

CONTENTS

Tar Oil Distillates As Dormant Spray Materials for Fruit Trees[1]

By R. H. Hurt, *Assistant Plant Pathologist*

Introduction

The introduction of tar oil distillates, tar creosotes, into the field of dormant spraying of fruit trees is the most important addition made in recent years to our knowledge of the control of certain fruit pests. The tar oil distillate sprays, or tar oil winter washes, as they are called in England, probably had their origin in a heavy German carbolineum. Hough **(2)** states that according to Parker **(8)** tar distillate washes had their origin in a German carbolineum which contained coal tar distillates as its base and was used originally as a wood preservative. H. Van Der Linden, a Dutch manufacturer of tar oil sprays, in correspondence with the writer states that a tar distillate wash was introduced into England by him in 1920 under the name of Carboleneum Krimpen, a preparation which had been used in Holland several years before that date.

According to Petherbridge and Weston **(9)**, the oil which they refer to as a carbolineum is one which is used for painting wood to protect it from rotting, and recently, also for protecting trees. They state further that carbolineum consists of heavy coal tar oil, so-called green oil (filtered anthracene oil), and that the ordinary carbolineum is unsuitable for spraying fruit trees. The material which they refer to as ordinary carbolineum corresponds to our low boiling point tar creosotes.

The use of tar oil sprays has rapidly spread throughout the world with the result that these materials are now used to some extent wherever fruit trees are grown. Petherbridge and Weston **(9)** are quoted as follows: "The introduction into this country (England) of the so-called 'carbolineum' winter washes has brought about a big change in the routine spraying of orchards; it is, indeed, the most important addition to our knowledge of the control of fruit pests that has been made for some time." The writer believes that such a statement will hold true for Virginia because the results obtained so far in Virginia indicate that tar oil creosotes of the proper kind have many valuable properties as dormant spray materials.

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[1]Paper No. 85 from the Department of Botany and Plant Pathology.

[2]Bold face figures in parenthesis refer to literature cited on page 16.

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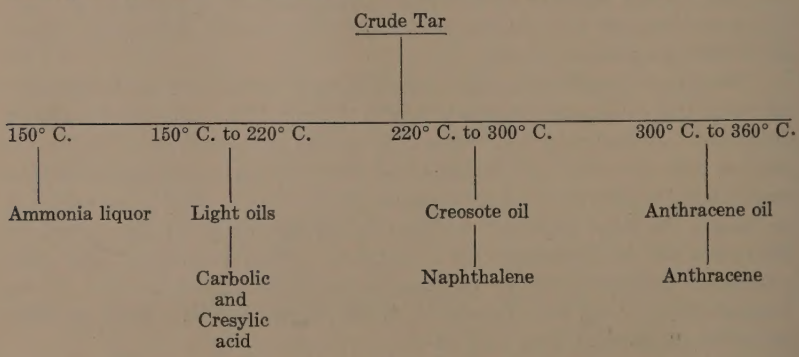
Tar Oil Distillates (Tar Oil Creosotes)

It would seem proper at this time to briefly discuss the source and properties of the materials which are commonly called tar oil distillates, or tar oil creosotes. The word tar distillate has a very broad meaning, hence the discussion will be limited to the tar distillates which can be used for spraying purposes and to those which might be of value as spray materials.

In the process of making coke from coal, quantities of crude tar are obtained as a by-product. The general characteristics of the various kinds of tar are determined by the nature and the proportion of their constituents, and these constituents vary according to the type of coal carbonized and also according to the conditions under which the distillation takes place. There have been several hundred substances identified in coal tar but only a limited number of these are of interest to the spraying industry. There are three main classes into which coal tar products fall according to their reaction; namely, neutral, acid and basic. These three classes of materials are found in some degree in the tar oil fractions which are used for spraying. The tar fractions, however, in which the fruit industry is mainly interested are the neutral and basic fractions which have a boiling point range between 225° C. and 400° C. The carbolic and cresylic acid fractions, however, are used to some extent at present as aphicides.

The products obtained in the distillation of coal tars vary to some extent depending upon the source of the coal and the process of distillation. The temperatures at which several of the distillates, which are of value in the spraying of fruit trees, are obtained and the products which are eventually obtained from them may be roughly expressed as follows: Light oils containing carbolic and cresylic acid, creosote oil containing naphthalene, and anthracene oil containing anthracene. These products are shown diagrammatically below.



The fractions of coal tar which are of interest to the fruit industry, or to the manufacturers of spray materials, are carbolic acid, cresylic acid (cresols),

and the creosote and anthracene oils. The creosote and the anthracene oil fractions are the portions of the tar oil distillate which are of special interest in view of the fact that these two fractions in combination make up the tar oil distillate which is best suited for use as a dormant spray material.

The creosote and anthracene fractions of tar oils are not generally separated by tar oil distillers in this country, only the naphthalene and anthracene being removed by chilling the oil and either filtering or allowing the solids to settle out. The resulting oil contains only a small amount of low boiling solids and is what is known as a long boiling range tar creosote oil. The tar oil distillate fractions which are intended for spraying work should have approximately the following boiling range; namely, starting at not below 225° C. and being all off at 400° C. The starting point of course may be very much higher than 225° C. but the maximum boiling point should not be over 400° C. for the best general results. A sample of tar creosote oil with a boiling range similar to tar oil creosote sample No. 5 (page 10) would be considered a very good grade of tar oil for spraying purposes. The tar oil creosote does not necessarily have to be redistilled so long as the naphthalene and other low boiling solids are removed.

The question has been raised **(2, 8)** as to whether tar oil distillates obtained from different crude tars, even though they have approximately the same boiling range, differ greatly in their chemical nature and properties. Tar oils from different sources of course differ, yet tar oil distillates with the same boiling range are about equally effective in their ability to destroy insect eggs irrespective of their origin.

Distillers of tar oils (tar creosotes) who are interested in furnishing tar oils to manufacturers and fruit growers should standardize their products to the point where they will have a boiling range of 225° C. to 400° C., with the naphthalene and anthracene removed to the extent that the oils will be free of solids when exposed to a temperature of approximately 40 degrees F. It is preferable to remove the tar acids but this is not absolutely necessary since tar oil creosotes containing as much as 5 to 10 percent tar acid may be used as a spray. All tar oil fractions are irritating to the skin and are more so if they contain a high percentage of tar acids. A fairly strong alkaline emulsifying agent helps somewhat to overcome the burning effect of tar acids and tar oils.

The Properties of Tar Oil Distillates (Tar Creosotes) in Relation to the Spraying of Fruit Trees

It was pointed out earlier in this bulletin that the tar products which are of most interest to fruit growers are the tar acids, tar bases, and neutral fractions, of which the tar oils are composed. Generally speaking the tar acids are removed from the tar creosotes at least down to 1 or 2 percent. On the other hand, the tar bases are rarely removed from the neutral fractions of the

tar oils. Thus the type of tar oil distillate which should go to the fruit grower will be composed largely of the high boiling basic and neutral fractions.

According to Martin (6) and Tutin (10), the portion of the tar oil most effective in destroying aphis eggs is the high-boiling neutral fractions. This does not mean, however, that other fractions will not destroy the eggs of aphis and other insects, for all tar oil products will have some effect on the shell of the aphis egg.

Tar oil fractions apparently cause a breaking down, or disintegration of the outer hard chitin layer of the aphis egg which results in the evaporation of the inner contents of the egg and eventually in the death of the young aphis. The tar acids, such as carbolic acid, have a very little disintegrating effect on the outer layer of the aphis egg. Cresylic acid (cresols) has some effect on breaking down the aphis egg shell and xylenol, which is a high-boiling tar acid, is more effective in this respect than either carbolic or cresylic acid. However, these tar acids do not approach the high boiling tar oil creosotes in effectiveness as an ovicide in the control of aphis and other insects in the egg stage.

According to Hough (3) and Hurt (5) tar oils are not as effective in the control of San Jose scale as are the petroleum oils which are now in common use for the control of this insect. Thus it becomes necessary to apply either a tar oil spray for aphis control and then follow with a petroleum oil spray for scale, or a tar oil-petroleum oil combination which will control both aphis and scale. Since the English tar washes contain no petroleum oil, the initial information relative to such a combination remained to be ascertained. Sufficient data have now been obtained to demonstrate that tar oils and petroleum oils may be used safely in combination for the control of San Jose scale and rosy aphis. Such an oil combination is also effective in controlling scale insects which pass the winter in the egg stage.

Experimental Results

Work was first begun with tar oil distillates in the spring of 1927 and since that time the writer has tested in various ways the properties of a great many samples of tar oils produced both in this country and in England. Reports by Parker (8), Tutin (10), Petherbridge and Weston (9), Martin (6), and Martin and Salmon (7), and others show clearly that tar oils of the proper kind are very effective in the control of aphis in the egg stage and also have a considerable cleaning-up effect on mosses which are so common on apple trees in England. Experiments conducted by the writer during the seasons of 1927 and 1928 using tar oil distillates available in this country gave promising results. The work of 1929 and 1930 was conducted on a much larger scale and very definite results were obtained as to the value of tar oils available in the United States for aphis control.

Spraying Experiments in 1929 and 1930

During the early part of March, 1929, a block of 12 York Imperial apple trees was sprayed with an emulsion made of a fairly heavy redistilled tar oil of American manufacture. The tar oil was emulsified with a soap solution in the spray tank and used at the rate of five gallons of actual tar oil in each 100 gallons of spray solution. The material was applied with a power sprayer, the trees being thoroughly drenched. For some reason unknown to the writer, very few rosy aphis developed in this orchard during the season. On the other hand, green aphis were very abundant and the control of this species of aphis was very marked in the tar oil plot. Only an occasional twig, which apparently was accidentally missed with the spray solution, showed any evidence of aphis; whereas, in the adjoining rows green aphids were very abundant on all of the buds.

In the 1930 trials, four different tar oils were used; namely, the English tar oil winter wash known as Mortegg winter wash, and three different grades of American tar creosote. The Mortegg winter wash was a miscible type oil emulsion and was used at the rate of 5 gallons in 95 gallons of water. The other tar oils were emulsified with a soap in the spray tank and used at the rate of 5 gallons of tar oil in each 100 gallons of spray solution. All of the applications were made with a power sprayer during the first week of March. The boiling ranges of the various tar oils used are given in another section of this bulletin.

The results of the above applications were all very good except where the light neutral tar oil was used. The aphis infestation in this orchard was about the same as it was in 1929; that is, there was a marked infestation of green aphis but very few rosy aphids even on unsprayed trees. The Mortegg winter wash (English preparation) and the heavy tar creosote oil emulsion gave excellent control of green aphis. The sample of ordinary American creosote emulsion gave very good results but not quite as good as either the Mortegg or the heavy American tar creosote. None of these tar oil sprays caused any injury to fruit buds and the trees in the test plots developed normally throughout the season.

Spraying Experiments in 1931

The work of the previous two years had shown that the light tar oil fractions and especially the light neutral fractions were not suitable for spray work, hence these fractions were not included in the 1931 experiments. The experiments consisted of the comparison of a commercial tar oil spray known as Barko with different concentrations of a local tar oil creosote emulsion made of a tar oil fraction obtained in the United States. This emulsion was made with a fairly heavy tar oil creosote having a boiling range between 235° C. and 400° C. emulsified with a soap. Two concentrations of the emulsion were

made; namely, a 77 percent stock and a 68 percent stock emulsion. The concentrations used and the results obtained in the 1931 test are given in Table 1.

Table 1. — Results of tar oil experiments in 1931.

Date sprayed, 1931	Materials used	Percentage of concentration	Percentage of aphis-injured apples at harvest
	J. W. QUICK'S ORCHARD, CROZET, VIRGINIA		
Feb. 25	Tar oil	4.76	1.7
	Tar oil distillate	2.72	4.1
	Barko* (Plot 1)	5.0	1.4
	Barko* (Plot 2)	5.0	7.2
	Check, not sprayed with tar oil		25.35
	C. P. McCUE'S ORCHARD, GREENWOOD, VIRGINIA		
Early March	Tar oil distillate	3.85	9.1
	Check, not sprayed with tar oil		66.6
	Barko*	5.0	3.05
	Check, not sprayed with tar oil		37.90
	J. W. MONTAGUE'S ORCHARD, GREENWOOD, VIRGINIA		
Middle of March	Tar oil distillate	2.72	8.0
	Check, not sprayed with tar oil		40.4

*Barko (tar oil spray).

The season of 1931 offered the first real test for tar oil emulsions in the control of rosy aphis. Previous experiments had indicated the value of these tar oil sprays in aphis control but the 1931 results not only demonstrated their value in controlling aphis in the egg stage but also showed that they could be used with safety on fruit trees. These experiments further showed that very good commercial control of aphis could be obtained with as low as 2.72 percent tar oil in the spray solution.

Spraying Experiments in 1932

The work conducted with tar oils prior to 1931 was carried on with the idea of determining the value of this type of oil as a spray for aphis control in the egg stage. A further object of these trials was to determine the safety of applying tar oil fractions under our conditions to fruit trees. It was also desirous to locate suitable distillate fractions in the United States for spraying work. Experiments conducted up to this time by Hough **(3)** and Hurt **(5)** indicated that tar oil fractions which were suitable for aphis control were not dependable for the control of San Jose scale.

With this situation in mind, the experiments of 1932 were planned with the view of further determining the possibility of combining tar oil distillates with petroleum oils which are commonly used for dormant spraying. These

tests were made using a constant percentage of petroleum oil with varying amounts of the tar oils. The materials and results are given in Table 2. The tar oil fractions are numbered 1, 2, 3, 4, 5, and 6. Wherever these numbers appear they refer to the tar oil creosote used.

Table 2. — Results of experiments conducted with tar oil-petroleum oil combinations on apple trees in J. W. Quick's orchard, Crozet, Virgiina, 1932.

Date sprayed, 1932	Combination of materials used	Amount of aphis injury	Percentage of scale injury	Amount of twig injury from spray
Feb. 16	Xylenol, 1%; petroleum oil, 3%	None	0.6	None
	Tar oil No. 1, 3%	None	None	None
	Tar oil No. 2, 3%	None	None	None
	Petroleum oil, 3% (check)	None	0.8	None
	Tar oil No. 1, 1%; petroleum oil, 3%	None	None	None
	Tar oil No. 1, 2%; petroleum oil, 3%	None	None	None
	Tar oil No. 1, 3%; petroleum oil, 3%	None	None	Trace
	Tar oil No. 1, 4%; petroleum oil, 3%	None	None	Trace
Feb. 25	Tar oil No. 2, 1%; petroleum oil, 3%	None	0.8	None
	Tar oil No. 2, 2%; petroleum oil, 3%	None	2.6	None
	Tar oil No. 2, 3%; petroleum oil, 3%	None	0.6	Trace
	Tar oil No. 2, 4%; petroleum oil, 3%	None	0.4	Trace
March 2	Tar oil No. 3, 3%; petroleum oil, 3%	None	0.2	Trace
	Tar oil No. 4, 4%; petroleum oil, 3%	None	0.4	None
	Petroleum oil, 3% (check)	None	None	None
	Tar oil No. 5, 1%; petroleum oil, 3%	None	None	None
	Tar oil No. 5, 3%; petroleum oil, 3%	None	None	None
	Cresylic acid, 0.5%; petroleum oil, 3%	None	No counts made	None
	Cresylic acid, 1%; petroleum oil, 3%	None	No counts made	None

Tar Oil Distillates (Tar Creosotes) Used in 1932 Experiments

The boiling points of the tar oil creosotes used in the 1932 experiments are listed below. These creosotes have been referred to above as tar oils Nos. 1, 2, 3, 4, 5, and 6, and are so listed below. The analysis of an English tar oil which is used for making one of the leading English tar washes is also given.

Tar oil No. 1 (fairly heavy tar creosote)

210° C. _____ not more than 1 percent
235° C. _____ not more than 10 percent
355° C. _____ not more than 65 percent
Tar acid not more than 2 percent

Tar oil No. 2 (heavy tar creosote)

235° C. _____ not more than 2 percent
315° C. _____ not more than 15 percent
355° C. _____ not more than 50 percent
400° C. _____ not more than 75 percent

Tar oil No. 3 (fairly heavy tar creosote)

210° C. _____ not more than 1 percent
235° C. _____ not more than 10 percent
300° C. _____ not more than 60 percent
355° C. _____ not more than 65 percent

Tar oil No. 4

Wood tar creosote
Boiling points not determined

Tar oil No. 5 (heavy tar creosote)

247° C.	not more than	5 percent
255° C.	not more than	10 percent
258° C.	not more than	20 percent
265° C.	not more than	30 percent
283° C.	not more than	50 percent
296° C.	not more than	60 percent
343° C.	not more than	70 percent
347° C.	not more than	80 percent

Tar acid approximately 2 percent

Tar oil No. 6 (English tar creosote used in one of the preparatory English tar washes)

210° C.	not more than	5.3 percent
235° C.	not more than	20.9 percent
270° C.	not more than	41.9 percent
315° C.	not more than	62.0 percent
355° C.	not more than	76.7 percent
Tar acid by volume		12.2 percent
Tar acid by weight		5.5 percent

Aphis infestation failed to develop in the experimental orchard at Crozet in 1932; therefore no results were obtained on aphis control (Table 2). Since 3 percent petroleum oil was used in all of the tests in 1932, it was not expected that San Jose scale would develop to any extent. The small percentage which did develop in a few of the spray plots does not reflect the control value of the various tar oil-petroleum oil combinations.

The interesting thing about the results given in Table 2 is that they clearly show that a very high oil concentration of tar oil-petroleum oil composition may be used without causing injury to either the tree or buds. In each of these plots there was a minimum number of 30 trees consisting of the following varieties: Delicious, Stayman, York Imperial, and Winesap. It should be noticed that where as much as 6 percent of oil was used, there was a trace of twig injury. This injury consisted of an occasional dead bud and caused a delay in the development of the other buds for approximately a week. The injury was very limited and would not have been noticed by the casual observer. However, these data indicate that under Virginia conditions the limit of safety is reached when a 6 percent concentration of oil is applied whether it be tar oil, petroleum oil, or a combination of these oils. This does not mean, however, that a 6 percent concentration of the stock emulsion is the limit because most miscible oils and stock emulsions contain in most cases as much as 20 percent water and an emulsifying agent. Thus from 6 to 8 gallons of most tar oil emulsions could be used in each 100 gallons of spray solution and still be within the limit. Results show that it is entirely safe to use a sufficient amount of tar oil and petroleum oil in combination to control both scale insects and aphis without injury to the fruit trees.

Table 3. — Results of tar oil-petroleum oil combinations on apple trees in C. P. McCue's orchard, Greenwood, Virginia, 1933.

Date sprayed, 1933	Materials used in 100 gallons of spray	Percentage of aphis injury to fruit at harvest
March 6	Cresylic acid, 1 gallon; petroleum oil, 6 gallons	3.60
March 13	Tarolene, 6 gallons	1.80
March 17	Arbo, a tar oil emulsion, 5 gallons	2.75
April 5	Cresylic acid, 0.5 gallon; petroleum oil, 2.5 gallons; water gas creosote, 1 gallon	7.60
	Check, not sprayed	30.38

All of the above applications reduced the infestation of aphis, but Tarolene and Arbo gave the best results. These two spray materials are composed of tar oil and petroleum oil. One percent cresylic acid in combination with 6 percent petroleum oil gave very good results in aphis control as a dormant spray. No injury to the buds and twigs of trees was observed in the plots which received the combination spray of 6 percent petroleum oil and 1 percent cresylic acid; however, such a mixture would not be practical and entirely safe under all dormant conditions. One-half percent cresylic acid in combination with one percent water gas creosote and 2.5 percent petroleum oil applied as a delayed dormant spray resulted in commercial control of aphis but caused considerable burning of the buds. The burning in this case was caused by the water gas creosote. This injury, however, was not serious, for as growth advanced the evidence of injury disappeared.

The Preparation of Tar Oil Creosote Emulsions

The emulsifying of tar oils which are suitable for spraying purposes is not accomplished as easily as the emulsifying of petroleum oils. The foreign preparations which were composed of straight tar oil were largely emulsified with sulfonated castor oil. Such an emulsifier under Virginia conditions is of course out of the question because its use would make the tar oil sprays too costly for practical use in aphis control. Since the tar oils are harder to emulsify than petroleum oils and furthermore have not been standardized by tar oil distillers for spraying purposes, it would seem best for the fruit grower to use the manufactured emulsions at the present time. The preparation of home-made tar oil emulsions, however, is not impossible since several large fruit growers in Virginia have already prepared and used these emulsions with success. For those who are interested in preparing tar oil-petroleum oil emulsions, or the straight tar oil emulsions, the following formula and directions are given:

Formula for Stock Emulsion

Tar oil (heavy tar oil creosote) ---------- 2.5 gallons
Petroleum oil, 150 degree viscosity -------- 2.0 gallons
Emulsifying solution ---------- 1.5 gallons

Formula for Emulsifying Solution

Sodium metasilicate	1.0 pound
Powdered casein	7.5 pounds
Water	15.0 gallons

In preparing tar oil emulsions the emulsifying solution must be prepared first. This is accomplished by heating the required amount of water to the boiling point, but the water does not necessarily have to boil. The metasilicate of soda is then added to the hot water and dissolved, a process requiring only a few seconds. The powdered casein is then gradually added with constant stirring. As soon as the casein powder has been thoroughly dissolved, which it does in a short time, the emulsifying solution is ready for use. The emulsifying solution should be passed through a strainer to take out any lumps of the casein which may have failed to become dissolved. It is best to use a piece of fine meshed screen wire for the straining of the emulsifying solution since this solution may clog up the tank strainer and become very difficult to remove after it dries.

If the tar oil-petroleum oil emulsion is to be prepared, the next step in the preparation is the blending of the tar and petroleum oils. This is accomplished by measuring out the proper amount of each oil and then mixing them in one or more barrels. After the tar and petroleum oils have been thoroughly mixed they are ready to be added to the spray tank which already contains the emulsifying solution in the proper strength.

After the proper amount of the emulsifying solution is added to the spray tank, the pump is started and the tar oil-petroleum mixture is gradually added in just the same way as in the preparation of the regular home-made petroleum oil emulsion. The procedure employed in completing the emulsion is the same as in the preparation of the home-made petroleum oil emulsions.

Growers who are not interested in using a combination oil spray but want to use a tar oil creosote for aphis control in the dormant stage, may prepare a straight tar oil emulsion. This is accomplished by the same procedure as that employed in preparing the tar oil-petroleum oil emulsion except that the petroleum oil is not blended with the tar oil. After the proper amount of the above emulsifying solution has been added to the spray tank, either the straight tar oil, or the blended tar oil and petroleum oil, may be added and emulsified. In either case the method of procedure is the same.

Directions for Using Tar Oil and Tar Oil-Petroleum Oil Emulsions

If the emulsion is prepared according to the formula given above it should be used on apple trees at the rate of from 6 to 7 gallons in each 100 gallons of spray solution. If San Jose scale is not a problem, as little as 5 gallons in each 100 gallons of spray solution is sufficient for the control of aphis. On the

other hand, if the grower has a heavy infestation of San Jose scale it will be advisable to use 7 or 8 gallons of the stock emulsion for each 100 gallons of spray solution. If a blended tar oil-petroleum oil emulsion is to be used, it is added to the spray tank in the same manner as any other oil emulsion. If the two oil emulsions are prepared separately, and used together, it makes little difference which one is added to the spray tank first.

The above directions apply only to tar oil emulsions prepared according to the formula given in this bulletin. If growers are using one of the proprietary tar oil emulsions they should follow the manufacturer's directions. This will be necessary in view of the fact that there will be several tar oil emulsions on the market which have not been tested by any experiment station. Manufacturers of spray materials are familiar with the amounts of tar oil creosote necessary to control aphis in the egg stage; but in using any tar oil spray, the grower should make sure that the stock materials contain enough tar oil to furnish at least as much as 2.5 gallons of actual tar oil creosote for each 100 gallons of spray solution. Since tar oil creosotes are not nearly so effective as petroleum oils (3) in the control of San Jose scale, tar oil-petroleum oil combinations should contain sufficient petroleum oil to assure scale control.

Time of Application

Tar oil creosote emulsions should be applied only when the buds are *completely dormant.* This applies to all forms of plants or trees where a tar oil spray is to be used. These preparations may be applied during favorable weather any time after the trees become dormant. If possible, quiet, warm days should be selected for the application of tar oil sprays. Remember that in order to destroy aphis eggs it is necessary that they be thoroughly covered with tar oil; and in order to do this, the tree must be thoroughly sprayed from top to bottom. Avoid spraying with tar oil emulsions, or any other oil emulsion for that matter, when the weather is expected to be very cold the following day.

There is a great deal of variation in the susceptibility of the skin of different spray operators to injury from tar oils. The skin of some operators is burned very easily, whereas that of others is not so easily burned. Care should be taken to protect the men and team from such tar oil injury. This may be accomplished by not spraying in windy weather and also by covering the team with waterproof covers. Hartzel and Parrott (1) state that burning of the skin may be lessened by washing with vinegar diluted 1 part to 3 parts of water. Rubbing alcohol is also very effective in neutralizing the burning effect of tar acids and tar oils. The spray operator should clean his face and hands thoroughly at noon and night by washing with soap and water after which alcohol is applied and rubbed in well. Greases, as a rule, are worth very little in protecting the face and hands of the spray operator from tar oil injury. If the

temperature is very high, the operator is better off without any kind of grease on his face and hands.

The Use of Tar Oil Creosote Sprays on Peach Trees

Since aphis control on peaches is not a problem, there appears no special reason why tar oil creosotes should be generally used as a dormant application for peach trees. There is evidence, however, to indicate that tar oil creosotes have some value in the control of the bacterial shot-hole disease of peaches. In view of the fact that these oils may be used safely on peach trees, the writer feels that they deserve a trial in the prevention of the bacterial shot-hole disease since there is now no practical method known for controlling this disease. Results so far indicate that it is safe to use as high as 6 gallons of standard tar oil emulsion to each 100 gallons of spray solution on peach trees when they are thoroughly dormant. Four to five gallons of actual tar oil creosote in each 100 gallons of spray solution may be used rather than the tar oil-petroleum oil combination. It is possible to use the tar oil emulsion with Bordeaux mixture or lime sulphur if the tar oil creosote is properly emulsified. There is not sufficient data in hand to state whether it is better to apply tar oil creosotes in the fall after the buds become dormant or in the spring just before the buds begin to swell. It is believed at the present time, however, that fall applications should prove more satisfactory from the standpoint of controlling the bacterial shot-hole disease, but there is danger of injury unless the trees are completely dormant.

There is not sufficient data available at the present to warrant the use of tar oil creosotes as a control measure for peach leaf curl. It is quite evident that the heavy tar oil creosotes have some value in the control of fungous diseases which pass the winter on the bark and buds of fruit trees, but this property may not prove of sufficient value to warrant the use of these oils for such purposes. Where oil sprays of any kind are used as dormant applications on peach trees, it is necessary to apply either Bordeaux mixture or lime sulphur in combination with the oil spray, or to follow the oil spray, with one of these fungicides, for the control of leaf curl. If tar oil creosotes, or tar oil-petroleum oil combinations, are to be used on peach trees, they should be applied when the trees are thoroughly dormant and during warm weather. It is better to have the temperature as high as 50° F., or higher, when the application is made.

Summary and Conclusions

Experimental results obtained with tar oil creosotes in Virginia over a 7-year period clearly show that these materials can be safely applied to thoroughly dormant fruit trees and that they are very effective in controlling aphis in the egg stage.

The minimum amount of the heavy tar oil creosote that can be depended upon for good aphis control is approximately 2.5 gallons in 100 gallons of the spray mixture. Less than this amount cannot be depended upon for satisfactory control of aphis.

When using tar oil creosotes and petroleum oils in combination for aphis and scale control, there should be not less than two gallons of petroleum oil with a viscosity of approximately 150 degrees (Sabolt) and not less than 2.5 gallons of a good heavy grade tar oil creosote in each 100 gallons of the spray mixture.

Tar oil creosotes and petroleum oils may be emulsified separately and used separately, or they may be emulsified separately or together and used in combination. It may be possible that certain manufacturers will furnish the fruit growers with either the straight tar oil creosote emulsions, or with miscible forms of tar oil creosotes. In that event, the tar oil creosote emulsions may be added to the home-made petroleum oil emulsions without any bad effect unless the manufacturer states otherwise.

Tar oil creosote emulsions or tar oil-petroleum oil emulsions should be applied to fruit trees when they are thoroughly dormant. Tar oil creosotes have been applied to apple and peach trees after the bud scales had begun to move without injury, but that is not a safe practice and should not be followed by fruit growers.

It must be remembered that in order to destroy insect eggs with tar oil creosotes, the eggs must be thoroughly covered with the spray solution. Therefore, since the aphis eggs are deposited on the small twigs and fruit buds as well as on the larger limbs, it is very necessary that all parts of the tree including twigs and buds be thoroughly covered with the spray solution. If the spraying is done in windy weather, one should not expect good results because the coverage will be poor.

Tar oil creosote sprays may be applied to fruit trees any time during the dormant season; however, for best results, the applications should not be made when the temperature is below 40° F. and preferably when the temperature is above 50° F.

LITERATURE CITED

(1) Hartzell, F. Z., and P. J. Parrott.
1933. Tar oil distillate emulsions for the control of the rosy aphis and other fruit insects. N. Y. State Agr. Exp. Sta. Bul. 636, 29 p.

(2) Hough, W. S.
1932. The efficiency of tar distillate sprays in controlling San Jose scale and scurfy scale in 1931. Rept. Jour. Econ. Ent. 25:613-617.

(3) ———————.
1933. The efficiency of tar distillate sprays in controlling San Jose scale in 1932. Rept. Jour. Econ. Ent. 26:470-473.

(4) Hudson, C. E.
1926. The control of aphis on black currants. Reprint Jour. Ministry of Agric. 8 p. (Africa).

(5) Hurt, R. H.
1931. Tar oil distillates as dormant spray materials. Va. State Hort. Soc. Ann. Rept. 20:99-104.

(6) Martin, Hubert.
1931. The examination of tar and mineral oil insecticides. Jour. Soc. Chem. Industry 50:91-94.

(7) Martin, H., and E. S. Salmon.
1931. The fungicidal properties of mineral, tar and vegetable oils. Jour. Agr. Sci. 21:638-658.

(8) Parker, T.
1924. Tar oil emulsions. F. B. G. Jour. Federated British Growers, Vol. 3:111-112. (London).

(9) Petherbridge, F. E., and W. A. R. Dillion-Weston.
1926. Trials of tar distillate washes in East Anglia in 1926. Jour. Ministry of Agr., Oct., 1926.

(10) Tutin, F.
1927. Investigations on tar distillate and other spray liquids. Rept. Agr. Hort. Res. Sta. (Long Ashton) Bristol, (1927) p. 81-90.